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Abstract. Three sets of LX-04 samples of 0.18 and 0.49 mm nominal thicknesses were all dynamically loaded by Sandia's Z-accelerator with a ramp compression wave with a 200 ns rise time and about 150 kb peak stress. The LX-04/lithium fluoride samples interface velocities were measured using VISAR's. Comparisons of experimental and computational results will be given. Compression and release isentropes both show some reaction and kinetic behavior of the LX-04. Experiments were also performed on fine-grained TATB. Future experiments on single crystals of HMX that are designed to measure the phase transition at high pressures will be discussed.

Isentropic compression experiments (ICE) were performed on LX-04 and fine-grained TATB using the "square short" assembly. In this configuration pairs of samples of thickness 200-600 μm were placed on driver panels of aluminum of base thickness 400 mm. Windows of LiF and later PMMA were bonded to the back of the HE samples to minimize wave interactions and to aid in the analysis. Pressure ramps of approximately 300 ns duration and peak pressure of 90-120 kbar were applied to the aluminum surface. The resulting HE/window interface velocities were recorded using single-point VISAR.

Six LX-04 samples (three pairs of 300 and 500 μm thickness and 6 mm diameter) were compressed to a peak pressure of 110 kbar. The increase in peak velocity and consequently peak pressure with increasing sample thickness suggests that the material has begun to react. This made standard characteristics analysis, which assumes rate independent response, difficult to perform.

Instead, the resulting waveforms were compared to hydrodynamic (HD) calculations. The calculations were performed with the HD code CALE. The code was run in Lagrangian mode with a Mie-Gruneissen equation of state assumed for the Al and ~~the~~ LiF window. The LX-04 was modeled using the reactive flow model of Tarver. The pressure drive was derived approximately from experimental current (B-dot) measurements. The calculation showed the increase in peak velocity (pressure) with propagation distance. However, the calculation showed the material to have stiffer response as reflected by a steeper waveform for the 500 μm sample. This is possibly due to the fact that the LX-04 reactive flow model was calibrated to shock loading experiments which may show more reaction than lower temperature isentropic loading experiments.

In the second set of experiments, which used LX-04 and fine-grained TATB, a modified or "tailored" pressure drive was applied to the sample. This was accomplished by firing a level of Z's capacitor banks early, producing a 200 ns prepulse followed by the usual 300 ns main pulse. A linear ramp will typically produce low pressure shocks that show up at the base of the velocity waveform. By gradually increasing the slope of the pressure drive with time, the low sound speed, low pressure wave is allowed propagate ahead of the higher density, higher pressure wave. The result is a pressure drive that can delay shock up and maintain isentropic compression loading over a greater sample thickness. This is of particular importance in the case of HE which has relatively low impedance and will typically shock up in only 200-300 μm under linear ramp loading.

Two experiments, each with 8 samples (consisting of 4 pairs of HE of thickness 300 and 500/600 μm), were performed on LX-04 and fine-grained TATB. A peak pressure of 90 kbar was applied to the Al which produced a peak pressure of approximately 80 kbar in the HE samples. As before, simulations showed the LX-04 being driven to reaction. However, the TATB, again simulated with the Tarver model, showed no such reaction.

On each panel a third VISAR probe was used to record the free surface velocity of the aluminum driver surface. By making this measurement, the input pressure drive of the aluminum can be more accurately determined. It is hoped that by using the velocity histories of the HE/window interface and the input pressure drive along with a reverse time integration hydrocode (Hayes), the stress-strain relation can be accurately determined.

In future ICE experiments we plan to compress samples of single crystal HMX to pressures of approximately 300 kbar. It is believed that HMX will undergo a phase transition at 270 kbar (Yoo). It should be relatively easy to detect this transition in the VISAR record since it is associated with a fairly significant (5-10%) volume change.

Acknowledgements

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References

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Figure Captions

1. Setup of LX-04 ICE panel. Four of these panels are assembled to form the square short.
2. Velocity-vs.-time profiles from first LX-04 ICE.
3. Comparison of LX-04 ICE data to hydro simulation.
4. Simulation of LX-04 ICE with tailored pressure input.

5. Simulation of TATB ICE with tailored pressure input.

Figure 1

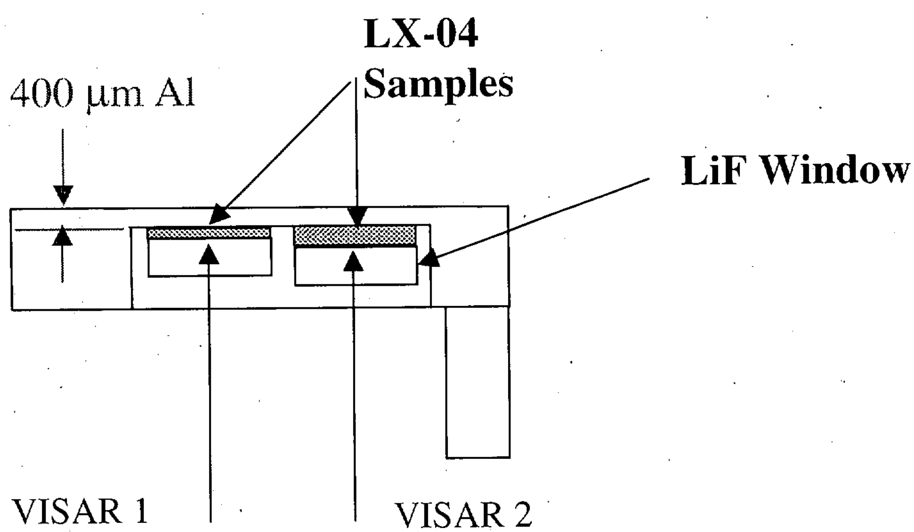

Figure 1

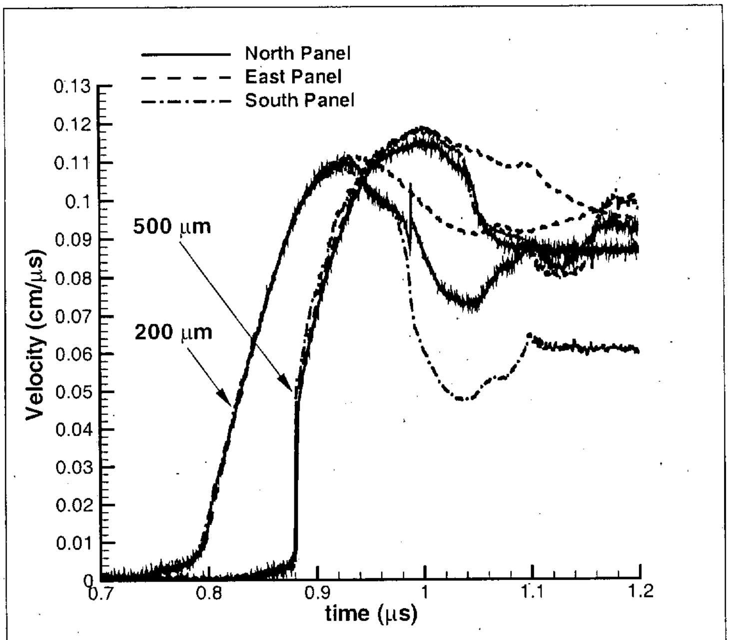

Figure 2

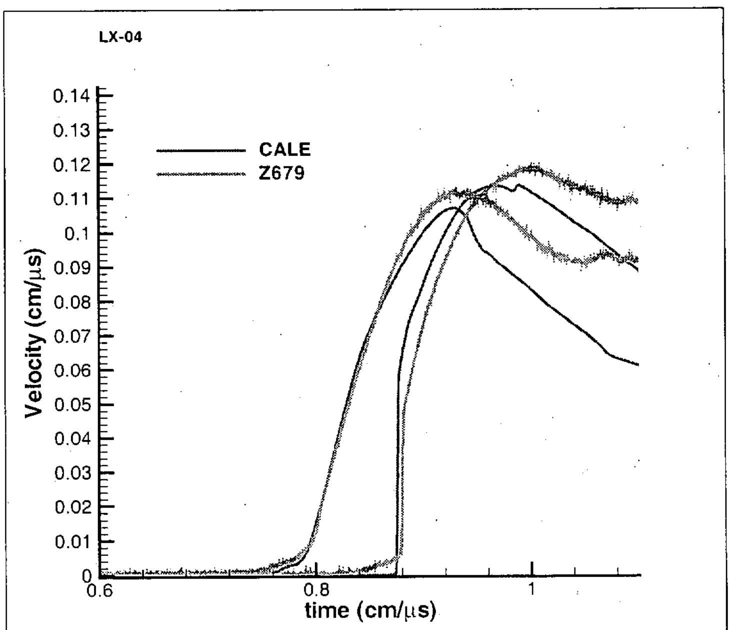

Figure 3

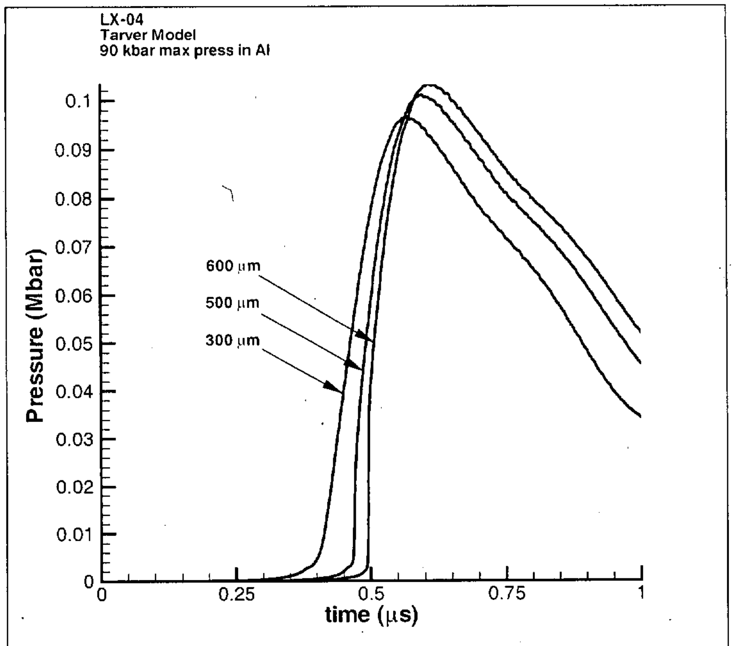

Figure 4

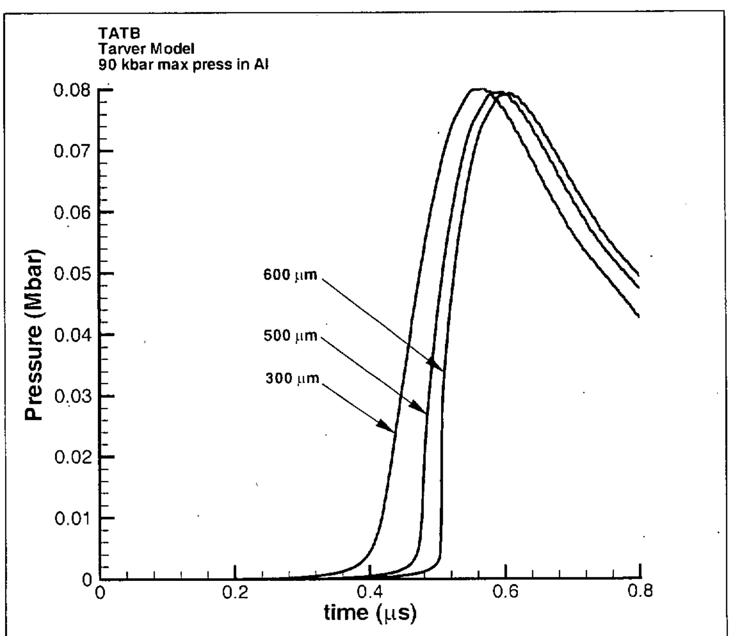

Figure 5